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(54) IMPROVEMENTS IN AND RELATING TO STRUCTURES OF REINFORCED ELASTOMERIC MATERIAL

(71) We, THE GOODYEAR TIRE & RUBBER COMPANY, a Company organized and existing under the laws of the State of Ohio, United States of America, of Akron, Ohio 44316, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to the producton of hose having a body cord-reinforced elastomer, and to the production of a composite cord-elastomer sheet or tape material which may be employed in the manufacture of such hose.

An important proportion of the hose made at the present time, in a wide range of sizes and especially for high pressure duty, incorporates a helically wound cord reinforcement. This so-called helically reinforced hose is almost invariably made with a balanced winding, that is to say with an equal number of similar windings applied in opposite senses, using either a plurality of cords wound helically on to the partly built hose, or a composite structure in which the cords are already secured to some sort of carrier which will become an integral part of the eventual hose. In the latter case the cords and carrier are generally manufactured as a continuous sheet which is, of course, potentially usable for other purposes such as the manufacture of reinforced belting, and for use in the production of hose is slit into relatively narrow bands which are then wound helically in the course of building the hose as indicated above.

Prior proposals in this field have not been entirely satisfactory. In some cases, the cords are wound without any sort of carrier, but the maintenance of the regular albeit small spacing between the cords is extremely difficult, and they are generally wound with adjacent edges touching. This results in a substantial discontinuity in the elastomer matrix if the hose, representing potential weakness to counteract which it is important to saturate the cord as far as possible with adhesive and generally to employ a strongly twisted cord, which adds considerably to the expense. Similarly, where the cords are carried on a support web, this would need to be heavily impregnated with adhesive (latex) to avoid a serious discontinuity in the rubber matrix of the hose, and represents an additional expense. Proposals have also been made to embed the cords, regularly spaced from one another, in a matrix of rubber by a calendering operation, to produce a composite sheet which can be slit as indicated above to provide a reinforced tape. However, in this case also it is in general necessary to employ a well twisted cord to prevent undue flattening in the calendering operation, and the operating conditions entail an excessively high proportion of elastomer to cord which increases the cost of the sheeting and of the eventual hose.

A preferred object of the invention is to provide a composite sheet structure comprising parallel spaced cords of high tensile monofilament material embedded in a matrix of elastomer in which the foregoing disadvantages are avoided or mitigated.

Another preferred object of the invention is to provide an improved helically reinforced hose having spaced apart cord reinforcement with a high cord : elastomer ratio.

Yet another preferred object is to enable high grade helically reinforced hose, and composite cord/elastomer sheet therefor, to be produced at reduced cost by the employment of substantially untwisted, so-called producers yarn.

The invention consists in a composite sheet material comprising parallel spaced

cords made of continuous filament yarn, either untwisted or possessing not more than one-half turn per inch length, embedded in a matrix of curable elastomer, the spacing between the cords being from one-quarter to four times the cord width and the matrix being either uniformly thick or having maximum thicknesses in register with the cords, such uniform thickness or maximum thicknesses being from 0.004 to 0.02 inches greater than the cord thickness.

The cords will normally be symmetrically disposed within the matrix, which will extend as a coating over each cord i.e. towards the surfaces of the sheet, and as a connecting web between adjacent cords. The coating thickness will accordingly be from 2-10 thou, usually 3-6 thou, whilst the web thickness between the cords will not normally be greater than the thickness of 1 cord plus the thickness of the coating at one side of the cord. The sheet will thus normally have a ribbed appearance, with the thinner areas between the cords. The degree of this ribbing, i.e. the difference between the sheet thickness at and between the cords, will depend to some extent on the cord diameter, on the cord spacing and on the nature of the elastomer material used for making the matrix as well as on the method employed for its production. However, in a typical case, employing latex of about 60% solids, and a spacing between the cords equal to the cord width, the thickness of the resulting coating of the coagulated latex over the yarn was found to be about 4-5 thou, and the thickness of the web between the yarns was found to vary little from about 25 thou, for a range of cord diameters of from 25-70 thou. Generally, the minimum web thickness will be 20 thou.

In the foregoing, the reference to the cord diameter is to the more or less circular cord prior to embodiment in the matrix whereas the references to the cord thickness and width refer to the cord in the matrix, the cord in this situation being in some cases slightly flattened.

A composite sheet material in accordance with the invention as described above affords a number of advantages. In particular, as compared with prior art proposals, it is markedly less expensive, in that it can be made from producers yarn and from relatively little elastomer without any sacrifice of quality in the eventually fabricated hose. Indeed, the quality of the resulting hose itself will in many cases be found to be superior, in that the spacing of the cords, which avoids the introduction of areas of discontinuity into the elastomer body of the hose, is achieved without the introduction of any extraneous carrier which is itself a potential source of weakneess and without the use of a relatively massive body of carrier elastomer such as would serve to prevent the attainment of the desired high concentration of the reinforcing cord.

Various techniques may be adopted to produce the composite sheet of the present invention. Thus, the invention also envisages a method of producing said composite sheet material wherein a monolayer of the said parallel spaced cords are coated with an aqueous emulsion of curable elastomer to yield a continuous elastomer matrix extending over and between the cords, and wherein the composite is then subjected to conditions resulting in coagulation of the emulsion to provide the said range of thickness.

The emulsion may be applied to the cord by dipping or spraying or by extrusion, in which latter case the cords may be fed through an extrusion nozzle in the form of a slot which may if desired have enlarged regions in register with the cords. The resulting unstable wet sheet may then be treated to coagulate the emulsion either by passing it immediately into a coagulating bath or by passing it through a heated chamber.

The emulsion is usually a latex of natural rubber, synthetic rubber or modified natural rubber.

Preferably sheets are made from latex for example by applying the latex to heated rolls, and the spaced cords are enveloped between the freshly made films whilst these are still in a condition such that they will bond together under light pressure. The two rubber films are then pressed together around the cords to form an encapsulating film.

In the foregoing description, the material of the matrix has been referred to as a curable elastomer, suitable for incorporation into a hose of elastomeric material which will be subjected to curing as a whole when finally built. It is an advantage of the invention that the relatively thin matrix of elastomer material employed as the basis of the reinforcing sheet is effectively cured or vulcanised by migration of curing or vulcanising agent from the surrounding body of the hose material although the incorporation of some curing agent is not precluded.

The invention will be described further with reference to Figures 1 to 6 of the schematic drawings accompanying the provisional specification of which:

Figure 1 is a sectional side view of apparatus for extruding latex sheet containing cord reinforcement,

Figure 2 is a view of the extrusion orifice,

Figure 3 is a cross-section of a resulting

composite sheet,

Figure 4 is a side view of apparatus for enveloping cord reinforcement between freshly prepared latex sheets,

Figure 5 is a sectional view of a resulting sheet,

Figure 6 is a side view of apparatus for making a composite sheet similar to that of Figure 5 by a dipping process,

Referring first of all to Figures 1-3, producers yarn is withdrawn from a plurality of creels 1 and fed round guide rollers 2 and 3 (each of which may be grooved or associated with combs to keep the cords 4 spaced from $\frac{1}{4}$ to 2 yarn widths apart,) through a latex bath 10 and then through an extrusion orifice 5 into a coagulant bath 11 from which the resulting composite sheet 12 (shown in cross-section on a larger scale in Figure 3) is fed round guide rollers 6 and 7 through a drier 8 to a wind-up roll 9. If desired the sheet 12 may be interleaved with a suitable non-stick sheet on the wind-up roll 9.

Referring next to Figures 4 and 5, the producers yarn is fed from the creels 13 through combs 14 and 15 to give the desired even spacing. The cords then pass between two heated rolls 16 which, through the "lick" or transfer rolls 17, transfer latex from the tanks 18 to the roll 16. This latex dries on the rolls to form a fresh film which is pressed gently on to the cords 19 to form an encapsulating matrix. The resulting composite sheet 20 is then wound on to the take-up roll 21.

The resulting sheet has a cross-section as shown in Figure 5, in which the cords 19. which are slightly flattened, are encapsulated in the rubber matrix 22.

The apparatus shown in Figure 6 is alternative to that shown in Figure 1 for coating the yarns or cords with latex. The cords 4 are drawn from the creels 1 and fed through a comb 14 to give an assembly of parallel spaced cords which is then led round the guide roller 2 into and through a latex tank 10. In this tank, guide rollers 3 and an agitator roller 23 secure that the latex remains homogenous and provide for even wetting of the individual yarns through the latex. The resulting latex coated composite sheet is then led through two doctor blades 24 to wipe excess latex away after which the sheet is pressed through a dilute (1-2%) acetic acid bath 11 to coagulate the latex. The sheet is then passed through a water rinse tank 24 and led out through a cold air jet tunnel 25 to dry it. Finally it is wound on to a take-up drum 21 on which it is interleaved with a fabric interliner 26 drawn from the supply wheel 27.

The elastomer normally used in carrying out the process of the present invention is natural rubber in the form of latex although of course the use of other synthetic or modified natural elastomer rubbers is not precluded. The latex preferably has the normal strength of about 60% solids although higher concentrations such as those found in creamed latex with some 70% solids can be used as well as more dilute lattices for example the material sold in the trade as "low concentration" with about 40% solids or even more dilute material down to 20% solids. However, the more dilute the latex is made as compared with the standard 60% material, the more water has to be removed during later processing. As already indicated, using the general 60% solids latex, the measured thickness of dry latex over the cords varies in a wide range of samples from about .004 to about .005 inches and the thickness of the latex web between the yarns in the coagulated form is fairly constant at about .025 to .030 inches over a wide range of cord thicknesses. However, these figures are given as a guide being those found by measurement of actual samples made and of course will vary according to the various parameters already mentioned such as cord spacing and latex concentration.

This expression "untwisted continuous filament yarn" will be understood to refer in particular to what is known in the trade as producers yarn which hitherto has been subjected to a twisting operation which considerably increases its cost before being used as a hose reinforcement. The expression "untwisted" means that it has not been subjected to any such twisting operation although in its as-produced form it may have a very low degree of twist, not more than one-half turn per inch length. A polyester yarn will normally be used, although other high tensile yarns for example of polypropylene are not precluded.

WHAT WE CLAIM IS:—

1. Composite sheet material comprising parallel spaced cords made of continuous filament yarn, either untwisted or possessing not more than one-half turn per inch length, embedded in a matrix of curable elastomer, the spacing between the cords being from one-quarter to four times the cord width and the matrix being either uniformly thick or having maximum thicknesses in register with the cords, such uniform thickness or maximum thicknesses being from 0.004 to 0.02 inches greater than the cord thickness.

2. A composite sheet material as claimed in claim 1 in which the spacing between the cords is from one half to twice the cord width.

3. A composite sheet material as claimed in claim 1 or 2 in which the matri extends as a connecting web between

adjacent cords and as a coating over each cord, the coating thickness being from 0.002 to 0.01 inches and the sheet material thereby having a ribbed structure.

4. A composite sheet material as claimed in claim 3 in which the web thickness between the cords is not greater than the thickness of one cord plus the thickness of the coating at one side of the cord.

5. A composite sheet material as claimed in claim 3 or 4 in which the minimum web thickness is 0.02 inches.

6. A composite sheet material as claimed in any one preceding claim in which the cord thickness is from 0.025 to 0.07 inches.

7. A composite sheet material as claimed in any one preceding claim in which the matrix comprises curable elastomer free from curing agents.

8. A composite sheet material as claimed in any one preceding claim in which the cords are polyester or polypropylene cords.

9. A composite sheet material as claimed in claim 1 and substantially as herein specifically described.

10. A method of producing the composite sheet material as claimed in any one preceding claim wherein a monolayer of the said parallel spaced cords are coated with an aqueous emulsion of curable elastomer to yield a continuous elastomer matrix extending over and between the cords, and wherein the composite is then subjected to conditions resulting in coagulation of the emulsion to provide the said range of thickness.

11. A method as claimed in claim 10 in which the emulsion is applied to the cords by dipping or spraying or by extrusion.

12. A method as claimed in claim 11 in which the extrusion is carried out through a slot having enlarged regions in register with the cords.

13. A method as claimed in any one of claims 10, 11 or 12 in which the emulsion is a latex of natural rubber, synthetic rubber, or modified natural rubber, and has a solids content from 20% to 70% by weight.

14. A method of producing the composite sheet material as claimed in any one of claims 1 to 9 in which a monolayer of the said parallel cords is enveloped between two sheets freshly made from elastmer emulsion which are subsequently pressed together around the cords to provide the matrix of the said range of thickness.

15. A method as claimed in claim 14 in which the sheets of elastomer are prepared by applying a latex of the elastomer to the heated roller.

16. A method as claimed in claim 10 or claim 14 and substantially as herein specifically described.

17. A composite material made by the process as claimed in any one of claims 10 to 16.

18. A hose having a helical reinforcing winding of composite material as claimed in any one of claims 1 to 9 or 17.

19. A hose as claimed in claim 18 comprising an equal number of similar helical windings in opposite directions.

20. A conveyor belt including a reinforcement of composite material as claimed in any of claims 1 to 9 and 17.

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3 SHEETS

PROVISIONAL SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.
SHEET 1

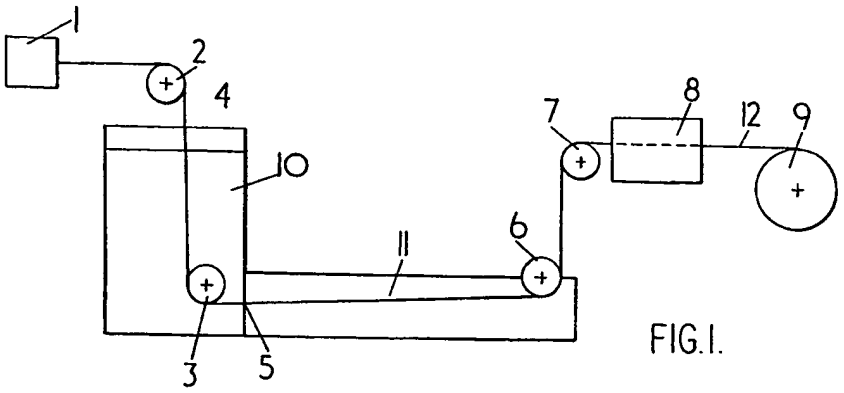

FIG.1.

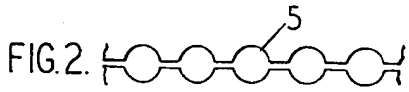

FIG.2.

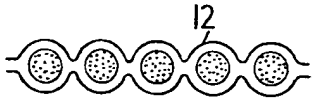

FIG.3.

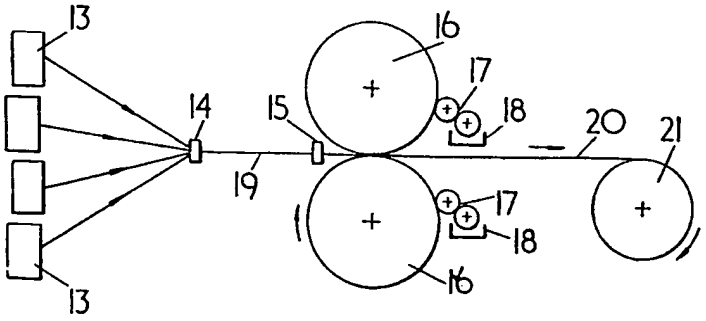

FIG.4.

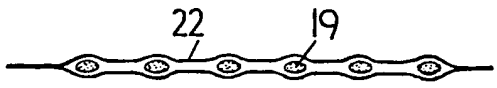

FIG.5.

1 440 081 PROVISIONAL SPECIFICATION
3 SHEETS

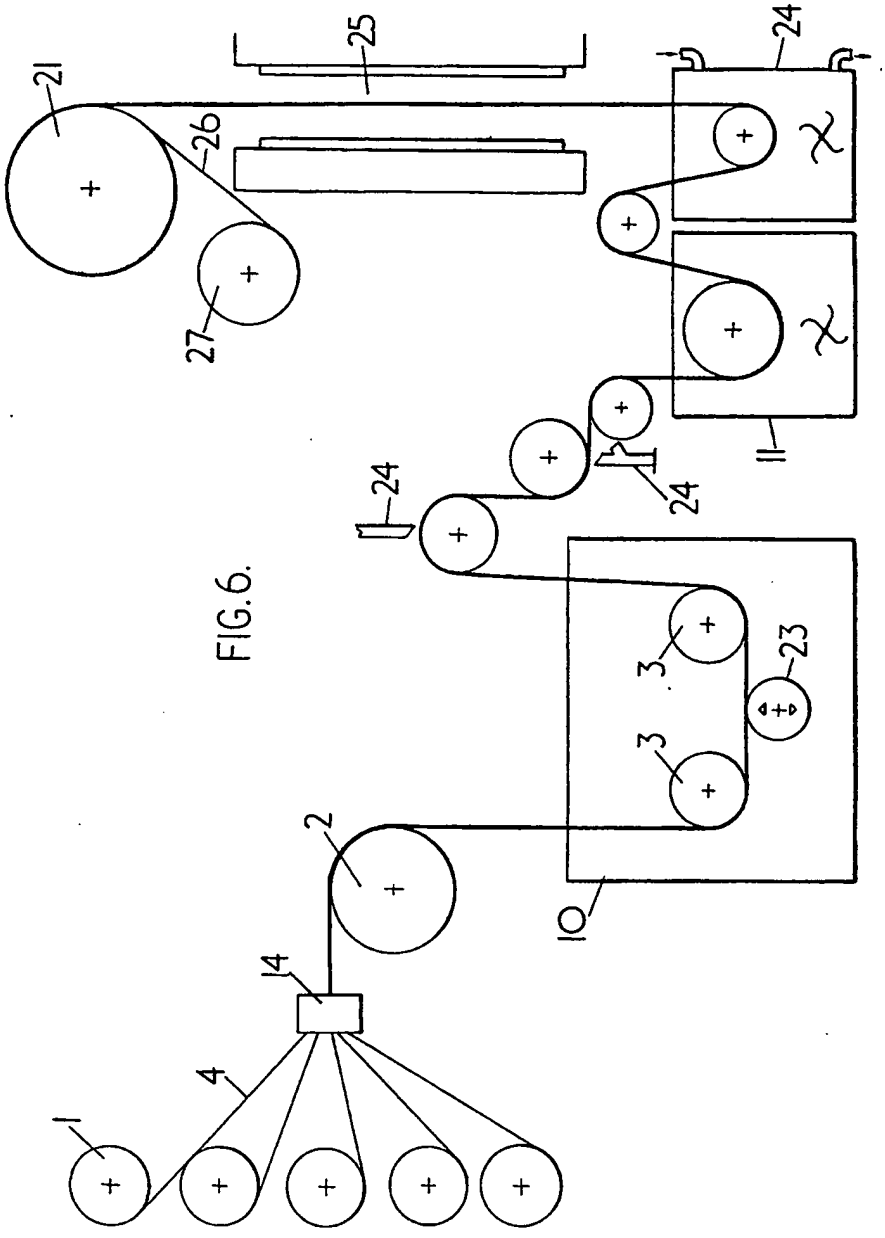

FIG. 6.